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ABSTRACT

Preservice and inservice teachers are expected to address individual differences in students. However, the nature of differences and the needs of individuals can slow or, at times, completely stop learning for the rest of the classroom. Teachers are also encouraged to teach higher level thinking skills, although standardized tests are often composed primarily of lower levels of questioning. By taking advantage of new technologies as they become available and combining them with old methods that are effective, teachers can accommodate individual learning differences and help develop higher thinking skills. The following steps for designing effective instruction while integrating new technology are described: (1) identify teaching goals and objectives; (2) identify required student assessment(s) and the relative importance of each; (3) identify resources, keeping objectives and assessments in mind; (4) allocate student time according to student assessments; (5) sort and match possible student activities to objectives, e.g., test preparation and portfolio activities should coordinate and students must be engaged; (6) monitor student progress according to assessment; and (7) evaluate and revise. (MES)

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Higher Level Thinking Skills and Individual Differences: Bridging Gaps with Technology

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Abstract: Pre-service and in-service teachers are expected to address individual differences in students. However, the nature of differences and the needs of individuals can slow or, at times, completely stop learning for the rest of the classroom. Teachers are also encouraged to teach higher level thinking skills, although standardized tests are often composed primarily of lower levels of questioning. By taking advantage of new technologies as they become available and combining them with old methods that are effective, teachers can accommodate individual learning differences and help develop higher thinking skills. Steps for designing effective instruction while integrating new technology are described.

Introduction

Two common instructional quandaries appear to be separate questions, but are interdependent: how best to address individual differences in students and how to correctly allocate student classroom time. Time schedules are established according to course objectives, which determine the content that is to be taught, which influences the level of required student thinking skills. Addressing individual differences, especially differences in cognitive ability, can destroy a classroom time schedule. Pre-service and in-service teachers can learn new ways to accommodate individual learning differences and effectively schedule student time through integration of appropriate technologies as they become available.

In a perfect world, instruction would always address individual differences in students. Eisner (1999) notes that ideal instruction enhances diversity. In other words, the higher quality of education, the greater the difference in student outcomes. Each student would experience challenge and would learn at the optimum rate for his ability. Individual talents would be expanded and individual interests stimulated. Differences would be addressed in formats that nurture positive outcomes for each student. In reality, the nature of those individual differences can slow or, at times, completely stop classroom learning.

The ideal is not always reality based nor is it easily attained. Teachers are encouraged to address individual differences and, at the same time, teach higher level thinking skills. If thinking and learning tasks are categorized according to the questioning levels of Bloom's taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwolh, 1956), those higher level thinking skills would be analysis, synthesis, and evaluation. In ideal learning conditions, creativity is stimulated as students develop and produce community centered projects. In the process, they use those higher level thinking skills. Student work is assessed by examination of portfolios that include many facets of the individual's work. In reality, project-based instruction takes a great deal of class time, precious time that teachers need for teaching and re-teaching the basics so that their students score well on required tests. This occurs because currently predominant assessments of teacher effectiveness and school quality are based on student achievement on standardized tests. Those tests primarily assess content acquisition at lower questioning levels: knowledge, comprehension, and application, according to Bloom's taxonomy. Accordingly, in order to satisfy that portion of teacher, school, or program evaluation that is based on student achievement scores, a great deal of classroom time must be spent on instruction and practice of the basics.

Teachers can become stressed because they are trying to address individual differences while stimulating higher level thinking skills within limited classroom time. Unless they learn new ways to plan, teachers are in a difficult situation! Pre-service and in-service teachers need skills that will allow them to make accommodations for physical, emotional, and behavioral disabilities while addressing differences in learning styles and cognitive ability. They also need new planning techniques for allocating classroom

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time so that higher level thinking and learning takes place without displacing time needed to prepare for tests that assess lower level thinking skills.

Specifics

Individual differences can cause serious problems in the classroom. A typical classroom includes students with a wide range of learning styles and cognitive abilities. Inclusionary laws that require the least restrictive environment have placed students with physical, emotional, and cognitive disabilities into most classrooms. In addition, many traditional classrooms contain students with undiagnosed or unclassified but evident emotional or behavioral disorders. Teachers often give direct instruction suited to the majority in the middle of the cognitive ability range, a process that ignores the needs of those at the high and low ends. For example, if direct instruction of a concept is presented to 30 students for fifteen minutes of class time, at the end of the fifteen minutes there would be several different levels of comprehension among the students. There might be ten students who understood the concept within the first five minutes. They are now completely bored because they had to spend ten extra minutes hearing the same information presented in several ways. After five minutes these students were ready to add new information. On the other hand, five different students still don't understand. They were paying attention and trying to comprehend, but they still have little grasp of the concept. They need more time and other presentation methods. For these five students it is difficult, if not pointless, to continue the same activity. Fifteen students are now restless and may begin to disrupt the learning of the rest of the class. Least visible outcomes are one or more students who simply sit, but don't learn. The other, more visible outcome can be cessation of learning by all in the classroom due to disruption by one whose needs are not being met in positive ways.

Teachers need the means to allow each student, whatever his level and ability, to work at his optimum growth rate. They need tools that will allow their students to acquire all levels of information and thinking skills. While teachers and technology can be excellent means of student learning, student interaction with teachers or with technology is not as important as student interaction with the instruction itself. Teachers need tools that allow each student to interact as directly as possible with his instruction.

Solutions

The key to teacher survival lies in having the ability to integrate the new with the old. New technologies can complement old methods that have proven effective. New teaching tools allow technology to assist with the time-consuming lower-level tasks of instruction: individualized instruction of content at knowledge, comprehension, and application levels. The use of computer-based or web-based K-12 learning resources for acquisition and/or drill and practice of content at lower cognitive levels can free up teacher and student time for projects that encourage higher level thinking skills. These resources can also address individual differences efficiently by allowing each student to interact with content at his optimum rate.

An example of a web-based learning resource is The Digital Bridge. The prototype unit of The Digital Bridge can be can be found at http://typhoon.coedu.usf.edu/~bmoore/wits2.htm. The instructional tools at this web site include objectives, essential terms and their definitions, tutorials of several types, links to other related information, flashcards, and quizzes. The site, which allows self-paced acquisition of knowledge, comprehension, and application levels of content, is designed to address individual differences in learning style and ability. Students can use the Digital Bridge as a learning resource individually or in pairs to acquire and practice one small segment of content at a time. The prototype unit covers an introduction to the concept of motion. The Digital Bridge is appropriate for enhancement of traditional instruction, but can also be useful for students in alternative educational settings. By taking advantage of new technologies as they become available, teachers can shift lower level learning tasks to the student. Teachers can spend more class time coaching students as they work in teams on community based projects, which, in turn, stimulate higher thinking skills.

Teachers are instructional designers. Not all teachers are designers of effective instruction. Successful instructional techniques, though they may differ in format, often include similar features. Geiger (1995) pointed out that effective instruction usually includes the following:

1. The student must be capable of the task.
2. The student must be relevantly active in the learning process.
3. The student must have incentive to interact.
4. The curricular materials must be flexible (individualizable).
5. Each task should result in an identifiable product (not necessarily teacher-defined, but having met certain criteria) for two reasons:
    a) The student and teacher both know that the task is completed.
    b) The product acts as a natural reinforcer for the student.
6. The student must come to feel satisfaction about the learning over time.

Designing Effective Instruction

Processes that occur in effective instruction must be carefully planned with constant anticipation of possible consequences and monitoring of actual consequences. Following an instructional sequence, the various outcomes must be analyzed and processes revised when necessary. Haphazard planning may result in a classroom filled with students industriously on task, but poor outcomes when student portfolios and/or standardized test scores are analyzed. The following steps for designing instruction incorporate success features and offer guidance for correct allocation of classroom time:

6. Identify teaching goals and objectives.
7. Identify required student assessment(s) and the relative importance of each.
8. Identify resources, keeping objectives and assessments in mind.
9. Allocate student time according to student assessments.
10. Sort and match possible student activities to objectives.
11. Monitor student progress according to assessment.
12. Evaluate and revise.

The steps are each explained briefly below.

13. Identify Teaching Goals and Objectives.

These items are available through department heads or supervisors. There should be complementary district and state level documents.

14. Identify Required Student Assessment(S) and the Relative Importance of Each.

There may be district, state, or national documentation of student progress in the form of:
- achievement tests: standardized, benchmark, or teacher designed.
- portfolios containing samples of work, evidence of product or performance, etc.
- combination of test and portfolio.

Identify the relative importance of each instrument. If it is a required instrument and is used as documentation of student benchmark progress or standardized achievement, or for teacher or school evaluation by any public entity, such as the school district, or state or national government, that instrument has extreme importance in designing instruction. Examine old tests and samples of grading rubrics for portfolios and take them into account when planning student activities.

15. Identify Resources Keeping Objectives and Assessments in Mind.

What activities are available to students both in and out of the classroom?
What related activities are available in the Media Center?
What activities have worked for successful teachers?
What technology is in the classroom?
What can be borrowed or signed up for?

Is there a computer lab?
What's the Technology Plan?

16. **Allocate Student Time According to Student Assessments.**

Class time should be allocated in proportion to student assessment(s). If half of student assessment consists of product or performance evidence contained in portfolios and half comes from standardized test scores, it is reasonable to schedule half of student time on portfolio activities and half on test preparation.

17. **Sort and Match Possible Student Activities to Objectives.**

Test preparation and portfolio activities should coordinate. If lab reports, research, and writing assignments are to be included in their portfolios, students should have basic knowledge and comprehension of terminology before starting the portfolio project. Constructivist learning research suggests that, given an assignment, a student will construct his needed body of knowledge, including vocabulary that would be covered on tests. While incidental learning that takes place during constructivist activities may be preferable to rote memorization, the practical issue of class time demands that student time and attention be spent on acquisition of basic facts. Unless students and parents can be relied upon to see that basic facts are acquired outside of class time, it becomes necessary to schedule class time for the acquisition of content.

Students must be engaged. Students can acquire lower level concepts (knowledge, comprehension, and application) using technology. With several learning resources or tools covering the same topic, each student can acquire necessary content at his own best pace. Technology automatically adjusts to the pace of the student.

- **Identify the product for the student.** The product, whether part of a portfolio or retention of certain body of knowledge, should be clearly identified to the student. If technology tools are used, they should identify small, achievable goals for the student and keep him aware of his progress.

- **Build product value for the student.** Student learning choices are made for individual reasons at any given moment. Teachers can become familiar with students' values through observation of student choices.

- **Learning should be relevant.** Portfolio and testing products should be related to students' lives. They will then become aware of the relationship of the topic to their own environment.

Build from student Knowledge Base. Use automated tools such as quizzes to assess student knowledge.

Expand the Knowledge Base. Let student move through acquisition of new information at his own best pace, in his optimum learning format. Technology with varied learning tools give students options that include text, graphics, and interaction.

Reach for community-based problem solving. The student becomes aware that his learning affects his community and, therefore, his own environment.

Encourage higher level thinking skills through constructivist learning sessions. Once the language and basic concepts are acquired to a degree that satisfies assessment, allow the student to reach into higher level thinking skills as his time allows. Each student will reach this point at a different time.

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18. **Monitor Student Progress According to Assessment.**

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1 Preliminary automated testing can monitor status of lower level content acquisition. Portfolio progress should be monitored often.

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19. **Evaluate the Activities Used and The Task Time Allotment.**

Are they producing desired outcomes (assessments)? If not, other activities should be considered and/or time allotment adjusted accordingly.

What Happens?

Using technology-based learning resources such as The Digital Bridge, each student can work at his own pace to acquire the vocabulary and application skills needed to plan and carry out lab experiments or community based projects. When the student knows his goals, is given the means to achieve them, and can monitor his own progress as he proceeds, he can assume responsibility for his learning.

Using on-line learning resources, students who learn quickly, completing required quizzes over assigned units ahead of the rest of the class, can move on to automated tasks that encourage higher level thinking skills. For example, The Digital Bridge prototype unit on Motion contains links to web-based lab activities that allow the student to manipulate variables via the computer, observe consequences, and make predictions about other possibilities.

After students have acquired basic information via self-paced web or computer-based instruction, they can then join other students to work on projects or actual lab experiments. Each student will be at a slightly different place in acquisition of vocabulary and basic concepts. The differences are not important, since each has acquired, at his optimum rate, as much as he is able. The alternative of group-presented direct instruction would have resulted in holding back fast learners and losing slow learners.

Should teachers worry about abandoning the direct teaching of thinking skills? Bereiter (1999) says "Forget about teaching people to think. Teach people things that are worth learning. Focus on goals and problems that really matter. Create an environment in which quality counts but where people feel safe in taking chances to achieve it. Then the thinking will take care of itself." (Bereiter, 1999, ch. 10, p. 37)

Conclusion

As technology becomes available, K-12 classroom processes are changing. Trips to the media center for research projects are being replaced by Internet research. Constructivist learning activities are replacing learning based on behaviorist and cognitive learning theories. The teacher role is shifting from dispenser of knowledge to learning coach. Student assessment is shifting from standardized tests to portfolios based on a variety of student products. But we're not there yet. None of the shifts are complete. There is wide variation in the status of procedural changes between classrooms, between schools, and between school districts. As the changes take place, neither the technology nor the theories that evolve from research can have any positive effect unless they are passed on to the people at the front line, classroom teachers.

Teacher training must address issues that are relevant to practicing teachers. Individual learning differences and correct classroom time allotment are important concerns for every educator and student. By helping teachers identify and combine effective old methods with appropriate new technologies, the gap between reality and the ideal can narrow if not disappear entirely.

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